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VOL. LV MARCH 31, 1922 No. 1422

Dedication of the Norman Bridge Laboratory of Physics of the California Institute of Technology:
Presentation: DR. NORMAN BRIDGE 327
Address of Acceptance: DR. R. A. MILLIKAN 330
A Joint Investigation of the Constitution of Matter and the Nature of Radiation: DR. GEORGE E. HALE 332
Research in the Norman Bridge Laboratory: DR. H. A. LORENTZ 334
Biotic Areas and Ecologic Habitats: DR. L. R. DICE 335
Capture in Atlantic Waters of the Giant Ray: DR. E. W. GUDGER 338
John Caspar Branner: DR. DAVID STARR JORDAN 340
Scientific Events:
The World Production of Coal in 1921; The Mount Everest Expedition; The American Chemical Society; The John Scott Medal Fund 341
Scientific Notes and News 344
University and Educational Notes 347
Discussion and Correspondence:
Selective Fertilization as an Indicator of Germinal Differences: DR. D. F. JONES. *Gravitational Absorption:* DR. PAUL R. HEYL 348
Scientific Books:
Wheeler on Social Beetles in British Guiana and Farquharson on the Bionomics of Southern Nigerian Insects: PROFESSOR T. D. A. COCKERELL 350
Special Articles:
Sealing Tungsten into Pyrex: DR. L. T. JONES. *A New Sclerotina on Mulberry:* E. A. SIEGLER and A. E. JENKINS 352
The American Mathematical Society: PROFESSOR R. G. D. RICHARDSON 354

DEDICATION OF THE NORMAN BRIDGE LABORATORY OF PHYSICS OF THE CALIFORNIA INSTITUTE OF TECHNOLOGY

PRESENTATION BY NORMAN BRIDGE

THIS is one of a series of pleasant occasions that have attended the growth and metamorphosis of this school for nearly a third of a century.

Each one has marked some accession of value in its progress from a small affair with varied aims and moderate ambitions, to a concentration of effort on the most ambitious plans for the selection and excellence of the few. Sometimes the acquisition has been a material one, as of buildings, grounds and tools; sometimes it has been spiritual and intellectual. To-day we welcome both forms.

The changes in the institution have come through a process of elimination of the casual and easy—designed for the many; and of the engrafting upon it of the more difficult, the more costly—and ultimately the more potent, for the few who can measure up to its requirements.

And the most telling addition of all has been the deliberate movement toward systematic research—otherwise the search for additions to the knowledge of the world.

We are gathered here to take note of the latest material addition to the equipment, as well as the latest spiritual and intellectual accession. This laboratory is undoubtedly a long step toward an ideal outfit for teaching, and for the research that is in the greatest demand at this time. But no man can guess what new facilities will be needed within a few years, for novel lines of research not now even thought of.

The growth of knowledge comes step by step; sometimes the steps are short, frequent, and strictly progressive; at other times they

are long, infrequent, and so radical that one step may require the recasting of a whole science. A hundred such instances stare us in the face, each one having sent a lot of the old apparatus of research to the scrap-heap. Such may some day be the fate of half the apparatus of this laboratory. If and when it comes it must be welcomed; if it will mean the achievement of vital economies for mankind—the exchange will be profitable, and the trade will be a good one. And you will then probably buy new and better apparatus, and go on with your research, but with new angles and for newly discovered purposes.

It was to be expected that such an expansion and elaboration in exacting education would occur here, on this hill—and with some such an institution as this. For, eons ago Providence, by the forces of the stars, made it certain that some day there would be here a great community of people, capable of such achievements as this movement represents, *provided* the land could be blessed with a stable and enduring government. Ages ago it was foredained to happen; it was bound to come, and come here —but with the indispensable peace-protecting and industry-protecting government.

Millions of years ago—yesterday morning it was, by the calendar of geologic time—the nearby mountains were lifted up by the buckling forces from below; and the off-shore currents of the more distant sea were then ordained to flow southward, and to flow *cold*. Then it was that the good luck of the low latitude and the right width of the low littoral, made it as sure as fate that here would be a wholesome climate, highly conducive to work and achievement, and that superior people would one day come hither in great numbers—given always a protecting government.

The influence of the mountains and the ocean—the shape and height of the mountains and the currents of air and sea; the width of the plain between, and the fortunate latitude, have made an ideal atmosphere on one lofty spot on the mountain for astronomical study—which study in our time has been realized in astounding fashion. In that day those forces also created here a multitude of engineering problems that are good for instruction, and for a challenge to research by some far-off generation of men. We stand to-day in the mid-period of that generation; and it would be a shame for us to fail.

Providence seems to have guided the human hands that have developed this institution as it is to-day. Really, it was a late discovery of a few people that nature had provided here the best conditions to make it the logical spot for a movement of this kind.

The first inspiration came to Amos Throop, a rugged, great soul with a far-reaching vision, who had been enticed here by the natural advantages for health and comfort. He knew how great these advantages are, and he knew that before many decades there would come about in this Southland the rapid growth of cities and the beehive of activity that we now see all about us. He saw that this community needed and deserved the best advantages of education and power. No such advantages had been provided for Pasadena. He had an ideal of a school to equip men to *do* things as well as to think and remember. His life had been keyed to practical in contradistinction to scholastic achievements. So he founded a Polytechnic Institute, and gave it all the money he had. By the measures of today the gift was not large, but it was greater than Mr. Carnegie or Mr. Rockefeller ever gave —for it was all he had. And he did what many givers of money forget to do; he gave himself with his gifts.

From that laudable beginning, this school of high college grade has grown. Now it summons from afar, and ofttimes invents, tools for its art unheard of before; and it calls from the ends of the earth the ablest experts into its faculty. Moreover, men famous in science come here to pursue further research with its facilities, under the inspiration of its work, and in the midst of its many advantages.

With all this development, the Institute has never departed from the original ideas of Mr. Throop ("Father Throop," as he was lovingly called) that it must in the highest degree possible give an education that shall fit men to *do* things in this rushing world of useful achievements—and a new civilization.

The new laboratory is the latest step in this practical direction, but by no means the last step. It is being equipped with all the practical things its designers could think necessary —but no human mind can foresee what new machinery may be needed on tomorrow—or some other morrow. In this particular the end is not yet; and the equipment will never be finished. It will always be growing and changing.

Another inspiration came out of a search for a good place for a Carnegie Observatory for the study of the sun and other stars. Should it be located here or across the sea; or across the equator? It must be put in the best place—for millions of money were sure to be spent upon it. The incomparable director of that work soon demonstrated the natural advantages of Mt. Wilson for the observatory. More than that, as this region bristles with scientific problems and interrogation points, he saw that here was the place of election for a great scientific school of the future. It not only belonged here, but it would be a wholesome neighbor to the Observatory. Then it was that Dr. Hale consented to become a trustee of this corporation, on the condition that the Board should fix a standard for the school, a little higher than that of any other then in existence. The Board, under the enthusiastic leadership of the then President, Dr. Scherer, promptly accepted the challenge; and it has, I believe, kept its promise, and maintained the condition.

But the plans for this higher emprise could not have been carried out, but for the vision, faith and unfalteringness of the Chairman of the Board, Mr. Fleming. His wisdom has, if possible, exceeded his determination; he has asked from others large gifts and got them; and, like the true soldier he is, he has led the way by making larger gifts himself. To use a colloquialism, he has been for years the very "angel" of the Institute. He does more good things, and talks less about them, than anybody else—and I nominate him as the most useful citizen in this community.

The evolution of a great laboratory is an absorbing subject—absorbing both in interest and money. Two years ago a laboratory of the physical sciences became a vital need of the Institute, if it were to go on in its progress without halting. It required a large expenditure of money. Some folks at our house, who had watched the growth of this movement from its beginning—and helped through its first two decades and more—had for long expected to do something more substantial toward its perfection than they had done before. Of course they knew of this urgent need and opportunity. But they were unable to see how they could provide even a small laboratory without losing so much time that opportunities and treasures of the first order were likely to be lost before the building could be completed. And the need was for a *great* laboratory, not a small one. Then a new light dawned, a hint from a genius, and the laboratory began to take form as a reality.

The program of this occasion says that the presentation of the laboratory is to be made by the donor. It ought to have said *donors*. For myself and Mrs. Bridge, some personal facts should be stated here; and one of them is that I appear here rather under false pretences. We could not have rapidly provided this magnificent and elaborate structure without the influence and connivance of that remarkable man already named, the wise and unselfish Chairman of the Board of Trustees. So, constructively he is in very essence one of the donors. Without his wisdom and faith, this building could not have been provided in time to function early, and early to embrace the greatest opportunity the institution has ever had. And as I am speaking in the presence of—as well as at, the head of the governing council of the Institute, who is also the Director of the Laboratory, I will, at the moment, spare his embarrassment by merely hinting at what that opportunity was. This community and the educational world are fast finding out what it was; and if God and the fates spare his life, they shall in good time realize it completely.

For myself, I beg to make a personal explanation and a confession—wherein may appear the evidence of the amazing vacillation of man. I

had long protested that my name should not be given to any endowment of anything that I might ever make; I protested against the use of it on this laboratory building; and the arguments of members of the Board and other friends, including the Director of the Laboratory himself, failed to move me in this particular—until I found that the vital member of my own household, who had for half a lifetime helped toward this opportunity, was in league with these people—then I surrendered. And I am ready now to confess to one comfort in seeing my name chiseled over the chief portal: it ought to tend toward discouraging the public from longer trying to impose on my name a final *S* and a middle initial!

As to the material contributions toward the building, they are made with utter gladness, with the knowledge that here shall develop a great center of education and research that will give the start and found the careers of many of the scholars and super-engineers of the future —and make life easier and more joyful, as well as more worth living, to vast numbers of people —for the men who are graduated here will carry the torch to others, and they to still others, on through an endless succession. Certainly no gift of mine already made, or that shall hereafter be made here, can possibly be a measure of my faith in this institution, and I have not for years had any official connection with it. My faith in it is greater than if I had a hand in its management.

Finally now, and in behalf of the donors and all the friends who have encouraged this consummation—those who have hoped and prayed for it; those who have planned and designed it and watched its growth; and those who have devised and furnished the sinews of construction that have made its walls arise into being—in behalf of all these and in their name, I commend and present this Laboratory of Physics—the last and best word in a modern workshop of nature's philosophy, to this corporation, and to you, Dr. Millikan, its Director—to you, Sir, who embody in your person the new spiritual and intellectual gift that comes with the Laboratory. And you are the hope and sure promise of the future!

ADDRESS OF ACCEPTANCE OF THE NORMAN BRIDGE LABORATORY OF PHYSICS

In accepting in the name of American physics this beautiful and well-appointed laboratory, I wish first to express on behalf of my colleagues and myself the appreciation and gratitude which we feel because of the opportunity which you, Mr. Fleming, and you, Dr. Bridge, have jointly opened up to us, not only of devoting ourselves to the intensive pursuit of the science which we love, but also of assisting in the solution of the fascinating and vitally important problems which the extraordinary developments in physics during the past two decades have pushed to the forefront of the world's needs to-day.

In the second place, I wish to accept this gift on behalf of the California Institute of Technology, with which I now have the honor to be connected, and to express its gratitude for the opportunity which is thus afforded it of taking another long stride forward toward the realization of the ideal which the far-visioned men who constitute the Board of Trustees have had from the beginning—an ideal not very common in American educational institutions, an ideal not of large growth in numbers, nor of the extension of the field of study over a large range of subjects, but rather the ideal of doing work of superlative quality in the chosen and relatively limited field of the Institute's activities—*the cultivation of the mathematical and physical sciences and their applications.*

In the third place, I wish to accept this gift on behalf of all those who, like myself, believe that the private educational institution still has a very vital role to play in the development of American civilization. I am no opponent of state education. From the common school up it represents one of America's most important contributions to modern life, and that contribution should be greater in the future than it has been in the past. But state-education is not all that is needed in this country. It can do something but not everything. Indeed, one of the most dangerous tendencies which confronts America to-day is the apparently growing tendency of her people to get

into the habit of calling upon the state to meet all their wants. The genius of the Anglo-Saxon race has in the past lain in the development of individual initiative, and if we lose that we shall lose our most priceless heritage. Even in the field of education the greatest and most distinctive contributions which our race has made thus far have been made through private institutions like Oxford, Harvard, and Chicago—institutions which are supported by men whom it has been our glory to develop in numbers found nowhere else in the world—*men who have treated their wealth and their talents as public trusts and have voluntarily devoted them to public ends.* I, for one, believe that some, at least, of our most important future contributions are going to come because we continue to develop such men and to preserve such ideals.

In the fourth place, I wish to accept this gift on behalf of American education, to which this institution hopes to contribute by its example an important element. We have succeeded in this country marvelously well in quantity or mass-education, as we have in quantity production. We have not as yet succeeded as well as have a number of other countries in quality education. We have not produced one-half as many—I think I may say one-fifth as many outstanding scientific and technical men in proportion to our population as have Holland, England, Germany, or France. The English honor system, to take but one example, has selected and trained the exceptional man in England and Canada as nothing in this country has thus far done, and after all the progress of civilization is determined by the very few men of vision and capacity which each age develops. There is then not only a place, but there is tremendous need in the United States for some schools which are designed to furnish exceptional opportunities and to give exceptional training to exceptional men. This has been the aim of the trustees of this Institute from the start. This is why the first step taken in the initiation of the work of the Norman Bridge Laboratory has been to provide something rare in America but something which the Institute already has, namely, an unexcelled staff in mathematical physics. Four-fifths of all teaching is the teaching of example. Creative men arise spontaneously in an atmosphere in which creative men exist and in general nowhere else.

But there is a second reason for accepting this gift in behalf of American education. With the gradual disappearance of the classics and the rigid discipline which they furnished, as the basis of our higher educational system, there have been slowly creeping into it during the past two decades certain emasculating influences which need to be counteracted. There is no Elisha upon whom the mantle of the classics can fall except the mathematical and physical sciences. There is no training like that which they furnish for teaching men to apply themselves intensively, to observe carefully and correctly, to treat their data honestly and dispassionately, and to reason objectively from a given set of conditions to their inevitable consequences—in a word to see clearly and to think straight. Indeed, there is nothing else left to constitute the backbone of the training of the coming generation if it is to maintain the virility and the strength of those that have preceded. The Institute hopes to do some pioneer work in demonstrating the values of an education having the mathematical and physical sciences for its backbone. I accept this gift, then, in behalf of American education in the confident belief that the intensive training in the mathematical and physical sciences which will take place within its walls may exert a wholesome, yes, a saving influence upon American education as a whole.

In the fifth place, if I may be so presumptuous, I wish to accept this gift in the name of Southern California, of which I have been a resident for the whole of three months, for I believe that this enterprise here is not a local enterprise. I believe that there is a contribution which it can and will make to the intellectual and cultural development of this whole empire of the south, which with all that it has of stimulating climate, of enterprise, of wealth, and of business capacity, still needs throughout its length and breadth the stability and sanity—in a word the culture—which a center of rigorous, objective, scientific thinking should

help to impart to it. Nor is this enterprise one which should influence Southern California alone, for since men of affairs come to this region as to scarcely any other region in the United States, no section is more favored than is this one in its opportunity of contributing its own good things to the progress of the country as a whole.

Finally, I wish to accept this gift in the name of all those who believe, as I do and as the trustees of this institution have from the start believed, that science in itself is not the most important thing in this world, but that the salvation of the world is to be found in the cultivation of science together with the cultivation of a belief in the reality of moral and spiritual values. Science alone may destroy this world instead of saving it, but the trustees of this institution have from the start differentiated it from most technical schools in the altogether exceptional emphasis which has been laid in its curriculum upon cultural and spiritual development. One expression of this ideal is seen in the atmosphere which has been thrown about the campus by the architectural beauty of the buildings which are already found here, a beauty which the architect, Mr. Goodhue, has known how to put in exceptional degree both into the exterior and the interior of the Norman Bridge Laboratory. I accept your magnificent gift, Dr. Bridge, in the hope and the belief that it will be an important factor in the creation at the California Institute of Technology, not only of men with the highest technical skill, but of men of the finest character and of the broadest citizenship.

R. A. MILLIKAN

A JOINT INVESTIGATION OF THE CONSTITUTION OF MATTER AND THE NATURE OF RADIATION

THE establishment of the Norman Bridge Laboratory of Physics, if my estimate is correct, is an event of no small significance in the progress of science. Dr. Millikan has explained its bearing on scientific and technical education, and pointed out that research, as conducted in the Bridge Laboratory and the Gates Chemical Laboratory, accompanied by the best instruction in physics, chemistry, and mathematics, must provide the firmest of foundations for the entire superstructure of the California Institute of Technology. It remains for me to speak of a joint investigation of the constitution of matter and the nature of radiation which the organization of the Bridge and Gates Laboratories has rendered possible.

Matter occurs in nature under the widest variety of composition and form. The physicist, who approaches this complex problem by the simplest and most direct route, deals chiefly with the chemical elements, and evolves powerful methods of research which enable him to penetrate to the core of the atom, to visualize the electrons swinging in their orbits, and to remove them one by one for detailed study. The chemist, concerned primarily with the union of atoms into molecules, and the combination of molecules of one or more elements, necessarily attacks matter of greater complexity, extending all the way from the single atom of hydrogen to compounds containing hundreds of linked atoms of many kinds. The astrophysicist, permitted by his powerful telescopes to penetrate to the depths of the universe, observes matter in the state of luminous gaseous elements, associated in the cooler stars with certain chemical compounds. The cosmic crucibles in this vast laboratory of nature exhibit conditions of temperature and pressure often transcending those attainable on earth, and thus present for observation experiments on an immense scale, the interpretation of which has already added much to our knowledge of physics and chemistry. A general study of the constitution of matter should therefore approach the problem simultaneously along the converging lines of physics, chemistry, and astrophysics.

The progress of research, particularly during the last quarter century, has brought us to the present critical juncture, when the possibilities of such a joint investigation are especially favorable. In each of the branches of science involved the methods and instruments of research have advanced to a high degree of per-

[1] Address at the dedication of the Norman Bridge Laboratory.

fection. Discovery has followed discovery, now in one subject, now in another, each throwing new and increasing illumination into the other fields. The application of the spectroscope to astronomy, affording the means of determining the chemical composition, distances, motions, temperatures, pressures, densities, and masses of the stars, has led to many advances of fundamental importance. The rise of physical chemistry, which revealed the role played by electrically charged particles in solutions and established for chemistry a rational underlying theory, opened another new world of thought. The extraordinary discoveries and developments in physics, particularly in the fields of radioactivity, the electrical nature of matter, X-rays and radiation, have brought to light wholly unexpected relationships between the elements which are of the greatest significance, both from the purely scientific and the practical point of view.

We now know that there are just 92 elements in nature, the heaviest of which are spontaneously breaking up into lighter ones. The basic element hydrogen exists throughout the universe, accompanied by other elements in varying proportions and states. A few stable elements can be broken up by artificial means in the laboratory, but no method of combining their constituents has yet been found. In the stars, however, there is strong reason to believe that the heavier elements are actually being built up from lighter ones, under conditions involving phenomena of radiation and absorption of energy as yet unknown on the earth. We should therefore not be limited to any single line of procedure, but should organize our attack in such a way that physics, chemistry, and astrophysics may all play adequate parts.

In the development in Pasadena of a single center for this purpose, the equipment needed for physics is now supplied by the establishment of the Norman Bridge Laboratory, with its powerful instruments and adjuncts, including a high tension laboratory, containing a million volt transformer, provided by the Southern California Edison Company. The Gates Laboratory, with many added facilities, will meet the necessary requirements for chemistry. The Mount Wilson Observatory, with its telescopes on Mount Wilson and its laboratories and instrument shops in Pasadena, provides for astrophysics. Thus the material means are not lacking, while the excellent atmospheric conditions, available sites for physical experiments ranging from sea-level to easily accessible mountain stations up to 12,000 feet, a neighboring Army Balloon School for free air experiments, and ample sources of hydroelectric power meet the needs of the widest research activities.

Most fundamental of all, however, is the research staff, and we are fortunate indeed in the recent accession of Dr. Millikan and Dr. Epstein, and in the privilege of having Professor Lorentz with us during the present winter. Mathematical physics must play a prominent part in our joint efforts, and the cooperation of the leading authorities in this field is essential. The combined corps of investigators of the Institute laboratories and of the Observatory, powerfully supplemented by our eminent Research Associates, is now well qualified to open an effective campaign. Indeed, if time permitted, I could show you how it has already begun.

A detailed report on the proposed joint investigation was presented by the California Institute to the Carnegie Corporation of New York in September. This was referred to President Merriam and the Executive Committee of the Carnegie Institution of Washington, who cordially endorsed the project and agreed to administer any funds for its support that might be granted by the Corporation. At its meeting on November 17 the Carnegie Corporation appropriated thirty thousand dollars per year for five years to the Carnegie Institution of Washington, to be accepted and administered by the Institution for the support of fundamental researches in physics and chemistry to be conducted at the California Institute of Technology. Dr. Millikan and Dr. Noyes have been appointed Research Associates of the Carnegie Institution, and the appropriation will be expended under their direction. Supplementing, as it does so generously, the research funds of the California Institute, this appropriation

provides the added means required for the joint investigation in conjunction with the Mount Wilson Observatory, a department of the Carnegie Institution of Washington.

It is hardly necessary to say that this liberal action is most heartily appreciated by the Trustees of the California Institute, who are thus encouraged to continue and to extend their policy of developing fundamental research in science and engineering.

GEORGE E. HALE

RESEARCH IN THE NORMAN BRIDGE LABORATORY

IT is a great honor to me to have been requested to address you on this memorable occasion and I have many good reasons for being interested in to-day's proceedings. In the first place, I have been so kindly and warmly welcomed by the scientific men of the institute that I feel almost as if I belonged to them and as if I also were going to have a share in the facilities for scientific research that have now been put at their disposal.

In the second place, I have for a long time admired Professor Millikan's important work, and I have now some idea of his great energy and activity, wondering how he can do all he does. I therefore heartily rejoice at this splendid opportunity being offered him to work on his favorite subject. He is going to have a laboratory that is worthy of him as was his wish, with Professor Noyes and his chemists and with the Mount Wilson Observatory close at hand.

But apart from these personal feelings the great development that has been inaugurated here to-day has my warmest sympathy. This would have been the case even if I never had come to this country. I am happy to say so. Indeed, even when separated by oceans, physicists form a kind of fraternity spread all over the world. It is true that the ties that unite them have not at all times been equally strong and that they have to a certain extent been severed in the disastrous period through which the world has passed. But, though we recognize that this could hardly be otherwise, we sincerely hope that in the end the feeling of good comradeship, such as is natural among men who have before them a great and important common task, will again prevail. It can not be too much emphasized that the understanding of Nature's secrets, that the use of knowledge of forces of greater urgency, and that much remains to be done, will join all workers. Certainly each individual worker will do his best to follow his own inclinations and to act according to his special abilities, and it is highly desirable that the research work of each nation bear the mark of its mentality and national aptitudes but by mutual aid and cooperation, one stimulating the other, all can be blended in one great effort.

I am deeply convinced that it must be so and therefore I feel that Dr. Norman Bridge, who is so generously promoting scientific research in this country, deserves the warm thanks, not only of Americans, but of scientific men.

And now when he takes off his evening dress, and has returned to his every-day life, Professor Millikan will set to work in his laboratory. You know what he can do, what marvels he can achieve with a single oil drop, determining, more certainly that ever was done, the electric charge and the manner and the number of the smallest particles of which matter consists. This afternoon we heard from him how he has been able to extend his investigations to ultraviolet invisible rays of the very smallest wave lengths. He is planning to send up high in the atmosphere instruments which, when safely returned to the earth, will tell about radiations which exist at great altitudes and of which he wants to trace the origin, either of the earth or the heavens. And when the high tension laboratory is ready, he and his fellow workers will bombard matter with electrons moving with a velocity comparable with that of light and they will try to knock to pieces the atoms of our elements and to see what becomes of them.

In all this they will work with Professor Noyes of the Gates Chemical Laboratory and with the astronomers of Mount Wilson. If some effect can not be found on the earth they will look for it in the sun and if there is some new and not wholly understood phenomenon in solar physics, it will be reproduced and in-

vestigated in the Norman Bridge Laboratory.

Mr. Chairman, it is a great pleasure to me to express the best and most hearty wishes for the good success of the work that has now been set on foot.

H. A. LORENTZ

BIOTIC AREAS AND ECOLOGIC HABITATS AS UNITS FOR THE STATEMENT OF ANIMAL AND PLANT DISTRIBUTION

MORE precision in the statement of animal and plant distribution has become an urgent need. A specimen labeled "California" or "Africa" is obviously of little value in a critical study of distribution. But, though less obviously at fault, a record giving merely a city or county as a locality is still not of the greatest use. A number of distinctly different kinds of life conditions occur within a short distance of most towns, and in the western parts of the United States the life conditions within a single county may range from desert to moist forest and even to perpetual snow. Unless the life conditions under which a species lives are known we can gain little insight into the factors which govern its distribution.

A knowledge of the life conditions under which a species lives can not be obtained from a statement alone of geographical localities, no matter how exactly these may be given. Even a record of the precise acre on which a specimen has been taken means little unless the environmental conditions of the spot also are stated. Exact geographical records are necessary, but mention alone of a locality is not enough, and a complete record must include a statement of the environmental conditions as well as the locality.

Some sort of classification of the environmental conditions must, of course, be adopted if the conditions under which a species lives are to be stated concisely and with precision. Although I do not intend to propose here any new system of classification, either for environments or for biological distribution, I do wish to call attention to some of the units on which a classification must be based.

The units of biogeographical classification which I believe will prove most generally useful are two in number: (1) a unit of geographical extent forming a natural life area (faunal or floral area), and (2) the habitat or ecologic community. The statement of the faunal or floral areas and the habitats or communities in which a species is found, together with records of geographical localities, should give very accurately both the geographical distribution and the conditions under which the species exists.

Biogeographers have long made use of floral and faunal areas for the classification of distribution, and the importance of this unit of distribution is generally conceded. Some ecologists employ practically the same concept under such designations as "climatic formation" and "climax formation." The best term available to include the concept of both floral and faunal areas seems to be biotic area. A *biotic area,* then, may be defined as a geographic district, characterized by an assemblage of species and of ecological characteristics differing from those found in adjacent areas. A biotic area will usually, though not always, be also a climatic area, and will often be a distinct physiographic area as well.

The animal species found in a biotic area constitute a *fauna;* the plant species found in the same area constitute a *flora;* and the combined animal and plant species of the area may be termed a *biota.*

It has been generally presumed that the units of classification for ecological distribution and the units of biogeographical classification belong to different categories and can not be used together. However, I see no reason why the unit of ecological classification, the ecologic community, may not, for the exact statement of distribution, be combined with the unit of geographical distribution, the biota as above defined. In fact, I firmly believe, after considerable experience in the use of this combination in the field, that it forms an excellent method of stating distribution.

By this method each biotic area is considered to be made up of a number of *ecologic habitats,* the animals and plants of each habitat forming an *ecologic community.* The community

then, may be considered as a subdivision of a biota, with the same geographical limits. Some communities will extend over two or more adjacent biotic areas, and they may receive the same name in the various areas in which they occur. But no community is likely to be exactly the same in two biotic areas, for between the various areas there are definite general differences in the fauna and flora, and usually also in climate and physiography.

The terms ecologic habitat and ecologic community are here used to designate ecologic divisions of any rank. Field workers dealing with different systematic groups of animals and plants will probably find it convenient to use different grades of ecologic units, depending partly on the size and mobility of the organisms considered. The ecologic communities recognized for ants will probably be smaller in average area covered, and lesser in ecologic rank, than mammal communities will be.

The rank of ecologic community which will probably be most generally useful in field work is the association, using this term in the sense of any relatively stable community whether climax or not. For finer distinctions the association may be divided into communities of lower rank, such as strata, societies, and the like. However, if the habitats and communities are carefully described, the field worker need not worry about the rank of the ecologic divisions. The important thing is to record the field observations in such a way that the environmental relations of the species considered are clear.

The discrimination of biotas and ecologic communities is not easy. We must recognize at once that there are few sharp divisions in nature, and that the lines we draw must in many cases be arbitrary ones. Communities or biotas which are very distinct where typically developed, at their edges frequently shade off gradually into adjacent divisions. But often taxonomic groups, such as subspecies, pass gradually into other taxonomic forms without sharp boundaries. The classification of biotas and ecologic communities is no more difficult, and not essentially different in kind, from the classification of animal and plant species and larger taxonomic groups.

"Probably the best criterion for characterizing faunal (biotic) areas is the dominance of particular habitats. It is evident that in passing from one area to another a situation will be met where the dominant habitat of one area will equal in extent the dominant habitat of the other area. It is at this point that the line separating the two must be drawn."[1]

In the western parts of the United States, where the topography is often much broken and where the climatic districts frequently are sharply limited, it is often possible to mark the boundary between adjacent biotic areas with considerable precision. But in regions of slight topographic and climatic diversity, such as is the case over much of the eastern United States, the limits of the biotic areas are often not clearly defined. Indeed, in some cases, it might be impossible to determine within several hundred miles the position of the boundaries between adjacent areas. The biotic area, however, is still a useful concept, even though the position of the boundaries of some areas can not be stated exactly. To attempt an exact definition of the boundaries of adjacent areas between which there is a wide belt of overlapping is certain to result in confusion rather than in precision.

The distinguishing characters of animal habitats are frequently based on the vegetation, though sometimes on the physical characters such as the occurrence of rocks or water. There is a close correlation between the distribution of animal species and of types of vegetation, and even in places where the vegetation is not the dominant factor in the environment it often can be depended upon to give an index of the physical factors which affect the distribution of animals as well as plants.

However, it is not yet certain that the smaller animal communities correspond exactly in distribution to the smaller plant communities. The mollusks and insects and other invertebrates often seem to be restricted in distribu-

[1] Dice, 1916, *Univ. Calif. Publ. Zool.* 16: p. 299.

tion by other factors than the plants are, and it may be that the smaller divisions of ecologic communities will be different in animals and plants; and perhaps these smaller communities will differ even in different groups of animals. It will be well, therefore, for field workers not to depend too rigidly on the plants or on any other one factor in describing distribution.

Indeed, it may sometimes happen that even the faunal and floral areas, or the principal ecologic associations, for the various groups of organisms will differ. It certainly will not be best to force unruly facts of distribution to conform to any rigid system of description.

On the other hand, a classification of habitats and biotic areas will be of the greatest use when it is applicable, so far as possible, to all groups of animals and plants. For this reason the ecologic communities recognized for all organisms should correspond as nearly as possible without obscuring the facts.

To form a universal classification will require the establishment of more divisions than would a classification for one group of organisms alone. For mammals, for instance, the grouping of all the fresh-water environments of a faunal area into one nominal habitat, the aquatic, would probably suffice; but if fresh-water fishes, invertebrates, and plants are to be considered, a number of habitats in the water must be recognized. Even when mammals alone are considered it can do no harm to describe more than one aquatic habitat, and it is of great advantage to have a classification of wide application.

One of the great advantages of using ecologic habitats and biotic areas for the statement of distribution is that these units are not founded on the assumption that any one particular factor of the environment is most important in the limitation of distribution. Units of distributional classification based on a bias for some one particular factor, such as temperature, as being most important in the control of distribution can not have the confidence of persons who consider the basis of classification unsound, or at least unproved. But the facts of distribution can be described by the use of biotas and ecologic communities without an assumption that any one factor is all important. However, if one factor is actually the most important one in the control of distribution over any area, this relation is not obscured by the employment of the units of description suggested.

It is my opinion that we are not as yet sufficiently informed as to the exact distribution of any group of animals or plants to render possible anything more than a preliminary classification of distribution in any part of the world. I would emphasize, therefore, the need for the precise statement of distribution in terms of units which are capable of combination into a number of possible systems of classification, rather than to describe distribution in terms of large and relatively unstable biogeographical regions, life-zones, or ecologic formations.

With a knowledge of the biotas and ecologic communities of the world it will be an easy matter to compare floras and faunas of different geographic regions; or the communities of similar habitats of different biotic areas may be compared as desired. Zoogeographers and phytogeographers may, if they wish, combine biotic areas to form provinces, regions, or life-zones; and communities may be combined at pleasure by the ecologists to make formations or other large divisions.

The time has come in the study of the factors limiting distribution when little more progress can be made by statistical methods, the attempt to correlate the distribution of climate or other barriers to distribution and of groups of animals and plants in the mass. Rather we must critically determine the factors concerned in the distribution of individual species. To do this will require carefully controlled experiments in the laboratory, correlated with long continued measurement and observation of the physical and biological factors of the natural environments.

Before laboratory experiments can be efficiently carried out, however, we must know the exact distribution in nature of the species of animals and plants and their environments. This is the greatest need of biogeography at the present time: to describe biotic areas and habitats and to determine the precise habitat

distribution of each species. This work can be performed without any expensive equipment; good judgment and hard work in the field are the main requirements.

There is pressing need that the work of describing the biotic areas and habitats of the world should be speedily done. Through the influence of man's industrial activities the natural conditions of the world are rapidly passing, and in our more settled districts it is now difficult or impossible to find even small areas of the original habitats. It is important to determine quickly the habitat preferences of the native plants and animals, for these can surely be determined only in natural habitats. With the changes due to the presence of man numerous species have been introduced, others have greatly changed their abundance, and the whole balance of nature has been upset. It behooves us to record all we can of natural habitats and habitat preferences before it is too late.

L. R. DICE

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THE MOST NORTHERLY RECORD OF THE CAPTURE IN ATLANTIC WATERS OF THE UNITED STATES OF THE GIANT RAY, MANTA BIROSTRIS

LIKE many other ichthyologists I have long known that Manta drifts north with the Gulf Stream as far as Cape Lookout, North Carolina, where it is sometimes found in the Bight of the Cape or playing over the shoals which extend some 15 or 20 miles out to sea. Furthermore, I have presumed that it occasionally drifted further north, but until my attention was called to the matter recently I did not know that any scientific records of its occurrence north of that point had ever been made. However, as a matter of fact the earliest record of the occurrence of this gigantic ray in our waters is found in Lawson's voyage to North Carolina (1709)[1]. Lawson describes the "divil-fish" as shaped like a "scate," of great size, and having a very large pair of horns on its head. He notes its occurrence in the inlets of the great sandy bars separating the ocean from the sounds.

The next notice is found in Marc Catesby's "Account of Carolina and the Bahama Islands," an appendix to Vol. 2 of his "Natural History of Carolina, Florida, and the Bahama Islands, etc." 2 vols. London, 1743. Speaking of *"Diabolus marinus,* the devil-fish," which he says is a great ray having two horns on its head, he describes how one came afoul of the cable of "a sloop of 80 tons," in the harbor of Charleston, South Carolina, and dragged it about the harbor.

The first scientific record of the capture of the fish, with a careful description and excellent figures dates in the year 1824. In August, 1822, there was captured near the mouth of the Delaware Bay a specimen which was brought to Philadelphia and secured for the Academy of Natural Sciences. It was figured and described by LeSueur[2] in 1824. It was 15 or 16 feet wide, and 7 feet, 9 or 10 inches long without the tail (which LeSueur says was slightly over 8 feet long) and had a mouth 2½ feet wide. He described it under the name *Cephalopterus,* head-winged.

It seems to have been a matter of general knowledge at that time among the fishermen of Capes May and Henlopen that this gigantic ray occurred in the ocean off that region. At any rate, it is recorded that late in August, 1823, a crew of fishermen set out to capture one of the fishes, and that on September 9 they brought a specimen to New York. Here it was measured and described by Dr. S. L. Mitchill who published his account in the same year with LeSueur, 1824.[3] It was a record

[1] Lawson, John, "A new voyage to Carolina; containing the . . . natural history of that country, etc." London, 1709.

[2] Le Sueur, Description of several species of the genus Raia, of North America, *Journal Academy Natural Sciences,* Philadelphia, 1824, Vol. 4, pp. 115-121, 4 figs.

[3] Mitchill, S. L., Description of a new and gigantic species of the genus *Cephalopterus* of Dumeril, *Annals Lyceum Natural History,* New York, 1824, Vol. 6, pp. 23-29, 2 figs.

specimen, measuring 16 feet from tip to tip of pectorals, 10 feet, 9 inches from tip of head to root of tail, 17 feet, 3 inches over all (from tip of extended cephalic fins to tip of tail), and the widest part of the mouth cavity measured 3 feet, 9 inches along the curve. Mitchill calls this ray, *Cephalopterus vampyrus,* the oceanic vampire.

The next record was made by Mr. Henry W. Fowler[4], Curator of Fishes of the Academy of Natural Sciences of Philadelphia, in 1903. This specimen was taken in a pound net located about one mile out at sea off Stone Harbor, New Jersey, on September 1, 1903. Mr. Fowler saw only the parts brought to him and hence could give no measurements.

Until this writing, this has constituted our most northerly record in the United States of the capture of Manta. However, during the last week in August of this year, a crew of swordfish fishermen were cruising off Block Island when the man in the "pulpit" saw some great flat animal swimming under him. He quickly threw his harpoon into it and after a fight which lasted over three hours, the great ray succumbed and was towed into Block Island. Fortunately there was at Block Island at this time an expert photographer, Mrs. Florence E. Foster of this city, who was engaged in making moving picture films of swordfish fishing. She took a number of excellent pictures of this specimen of Manta, particularly of its gigantic mouth. One of these shows a sucking fish clinging to the inside of the upper jaw. Mrs. Foster has very kindly presented to the department of ichthyology of the American Museum a set of these photographs which are unique of their kind.

This fish is said to have been 14 feet wide between tip of the pectorals, and 7 feet long from head to base of tail, and to have weighed on the scales 1,686 pounds. It is the only specimen known to me that has been actually weighed, and it is significant that the weight runs far less than the "estimates" usually made of from 2 to 5 tons. The record width is said to be about 25 feet and the weight 10,000 pounds, but this has not been verified.

Another point of interest may be noted. The newspaper accounts say that there was a large spine or "sting" on the tail. Mrs. Foster did not see this but saw a wound on the tail near the base where a spine was said to have been torn off. There is much controversy among ichthyologists as to whether Manta is spined or spineless. The late Theodore Gill, the dean of American ichthyologists, once expressed to the writer his doubt as to whether Manta has a spine, and Jordan and Evermann in their "Fishes of North and Middle America" doubtfully give it a spine. However, LeSueur definitely says that both his (female) specimen and her fœtus had spines, and his figure shows the spine. Mitchill found no spine, but noted "a hump or knob, about the size of a hen's egg, at the root of the tail behind the dorsal fin." In this hump Holmes[5] found and figured a bone which seems to be either a rudimentary or a degenerate spine. This is an interesting matter and one deserving of further study.

It now remains only to call attention to the two localities where these giants abound and in which they have been taken in large numbers. The first and longest known is the harbor of Beaufort, South Carolina, made famous by William Elliott's classic work, "Carolina sports, by land and water; including incidents of devil-fishing, etc.", the first edition of which is dated Charleston (S. C.), 1846; the second, New York, 1850; the third, New York, 1859; and an English reprint of this, London, 1867. No more delightful book of its kind has ever been published.

The other locality is Captiva Inlet on the southwest coast of Florida where Dr. Russell J. Coles[6] operated extensively in 1909, 1914

[4] Fowler, H. W., The occurrence of three interesting fishes on the New Jersey coast, SCIENCE, 1903, N. S. Vol. 17, pp. 595-596.

[5] Holmes, F. S., Contributions to the natural history of the American devil-fish, etc., *Proceedings Elliott Society of Natural History,* 1856, Vol. 1: 39-46, 3 figs.

[6] Coles, Russell J., My fight with the devilfish. *American Museum Journal,* 1916, Vol. 16, pp. 217-227, 7 figs.—Natural history notes on the devilfish, *Manta birostris* (Walbaum) and *Mobula olfersi* (Müller), *Bulletin American Museum Natural History,* 1916, Vol. 35, pp. 649-657, 5 figs.

and 1915. During this last year Dr. Coles took a female specimen 18 feet wide, cut it up into segments of which he made plaster casts, and sent material and casts to the American Museum. From these Mr. J. C. Bell of our department of preparation made the life-sized cast which is one of the chief prizes of our Fish Hall.

The most complete account of the natural history of Manta is contained in an article by Dr. Theodore Gill, "The story of the devil-fish." *Smithsonian Miscellaneous Collections*, 1908, vol. 52, pp. 155-180. 15 figs.

E. W. Gudger

American Museum of Natural History

JOHN CASPER BRANNER

John Casper Branner, geologist and President Emeritus of Stanford University, was born in New Market, East Tennessee, July 4, 1850, and died in Palo Alto, California, on March 1, 1922. He entered Cornell University in 1870, soon after its organization, graduating in 1874 as Bachelor of Science, subsequently receiving the degree of Ph. D. from Indiana University and that of LL. D. from the University of California. In 1883 he married Susan D. Kennedy of Oneida, New York, and left three children: John K., architect, George C., geologist-philosopher, and Elsie, Mrs. Frederick Hall Fowler.

His advanced work at Cornell was under a great teacher of Geology, Charles Frederick Hartt, who (during vacations) acted as Imperial Geologist of Brazil. Thus with Orville A. Derby, Richard Rathbun, Herbert H. Smith, and other student assistants, Branner went to Brazil where, upon the death of Hartt in 1875, he became director of the Imperial Geological Commission. Afterward, Brazil having become a republic, he entered the service of the Sao Cyriaco Mining Company at Minas Geraes as engineer and interpreter. Later he again went to Brazil and to Argentina as special botanist for Thomas A. Edison in search of wood fitted for certain electrical uses, and still later represented the United States Department of Agriculture in the former country. Returning to America in 1883, he served as topographical geologist of the Survey of Pennsylvania, a position resigned to accept that of professor of geology in the University of Indiana, where his college friend, the present writer, had just been appointed President. In 1891, he entered the faculty of the newly founded Stanford University as professor of geology, later becoming vice-president of the institution. In 1913 when the title of Chancellor was created for me that I might be free for public service, he was elected President of the University, and held that office up to his retirement as Emeritus in 1917.

Branner directed three scientific expeditions to Brazil: one under the patronage of Alexander Agassiz in 1899, one in 1907 supported by Richard A. F. Penrose, a former assistant professor at Stanford, and a third in 1911 for the Brazilian government. This last made a geological and biological study of the coast north and south of the mouth of the Amazon river, the especial purpose being to determine the effect of the great volume of fresh water brought into the ocean by the Amazon upon the marine life of the ocean.

His publications include a volume on the Geology of Brazil, with a large number of special papers, and a grammar of the Portuguese language. His other memoirs on Geology and Physical Geography are very numerous; his "Bibliography of Clays and Arts" is an important contribution to that subject.

Branner was a fellow of the Geological Society of America, a member of the Geological Society of London, of the Société Géologique de France, the National Academy of Sciences, the American Philosophical Society. He was also a member and for a time president of the American Seismological Society, and associate editor of the *Journal of Geology*. In 1906 he was appointed to the California Earthquake Commission, and in 1915 served the United States government on the commission to investigate the land slides on the Panama Canal.

In 1911 the Hayden Medal was conferred upon him by the Academy of Natural Science of Philadelphia "in recognition of the value of contributions to geological science, and of

the benefits derived from his able and conscientious discharge of the official trusts confided to him."

In 1912 he published "How and Why Stories," a delightful collection of tales told by negroes in Tennessee, bearing on the episodes of creation—"how the snake lost his legs," and the like—quite worthy of place besides the Georgia tales of "Uncle Remus."

In person Branner was robust and vigorous, six feet in height and well proportioned, a man of attractive personality and excellent address. In college he was noted for his dry humor, unfailing readiness, and good nature. As a teacher he was singularly successful in training men to thorough and accurate dealing with problems of geology and mining, gaining the personal love and confidence of his students. Among his disciples are many of high standing in the profession—Herbert Hoover, Robert V. Anderson, Frank M. Anderson, Ralph Arnold, George H. Ashley, Carl H. Beal, Willis S. Blatchley, W. J. Crook, H. W. Durrell, Noah F. Drake, Frank L. Hess, Theodore L. Hoover, J. M. Hyde, D. S. Kimball, E. M. Kindle, Newton B. Knox, Henry Landes, Deane P. Mitchell, James H. Means, John F. Newsom, Frederick W. Nobs, Edward H. Nutter, W. A. Pritchard, A. H. Purdue, Milnor Roberts, Hugh Rose, Claude Siebenthal, E. K. Soper, Herbert S. Stark, Stephen Taber, Frederick P. Vickery, Gerald A. Waring, H. E. Williams, Hayes Young, and many others well known in science or mining. The "Branner Club" of Los Angeles is composed of his students in geology.

I must add a personal word. My acquaintance with Branner covers fifty-two years, the first two as fellow-student and fraternity brother in Delta Upsilon, the next thirty as fellow-teacher and co-worker in science in Indiana and in California, three more as my successor and colleague in administration of the educational work to which I gave the best twenty-five years of my life, and, finally, five years of retirement from active responsibility to the congenial work of writing out of the fullness of experience. In all these years he lived up to his motto, "I can get along without the respect of my neighbors, but not without the respect of *Number One*." And in maintaining self-respect, he won the regard of his neighbors of whatever degree. A righteous life helps to strengthen all who come in contact with it. "There is always room for a man of force and he makes room for many."

DAVID STARR JORDAN

SCIENTIFIC EVENTS

WORLD PRODUCTION OF COAL IN 1921

THE world's production of coal in 1921 dropped back to the level of 1909. From reports so far received, the United States Geological Survey estimates the total output at approximately 1,100,000,000 metric tons. This figure is subject to material revision.

In comparison with the feverish year 1920, the year just closed shows a decrease of more than 200,000,000 tons. The chief factors in the decrease were the British miners' strike which lasted from April to June, and—more important—a world-wide industrial depression. Prices collapsed early in the year, and the seaborne coal trade of the world fell off sharply. The consequent reduction in the volume of business offered to the shipping of the world has been an important element in the decline in ocean freight rates.

Of the major coal-producing nations, France and Germany were the only ones to show an increase. Progress in restoring the ruined mines of France is indicated by the steady increase in output of the past three years. In 1919, 22,000,000 tons were produced; in 1920, 25,000,000; in 1921, 29,000,000. A further increase of 12,000,000 tons, however, would be necessary to bring French production up to the level of 1913. German production of bituminous coal is also still far below the pre-war level although an increase was effected in 1921 as against 1920. German production of lignite in 1921 reached the highest point ever attained. The estimated output of 120,000,000 tons is an increase of 35,000,000 tons over the last year before the war.

The proportion contributed by the United States was 40.9 per cent., a larger share than in the years before the European war, but the smallest in any year since 1916.

The following table, prepared by W. I.

PRELIMINARY ESTIMATE OF THE WORLD'S COAL PRODUCTION IN CALENDAR YEARS 1919, 1920 AND 1921
(In metric tons of 2,204,622 lbs.)

COUNTRY	1919	1920	1921
Australia	10,736,321	13,176,426	[1]
Belgium	18,342,950	22,388,770	21,807,160
British India	22,991,217	17,356,889	[1]
Canada	12,411,328	15,088,175	13,300,000
China	23,000,000	19,500,000	[1]
Czechoslovakia	26,946,813	31,086,479	[1]
France	22,341,000	25,300,000	29,000,000
Germany—Coal	116,500,000[2]	140,757,433[2]	145,400,000[2]
Lignite	93,800,000	111,634,000	120,000,000
Japan	31,461,386	29,245,384	[1]
Union of South Africa	9,313,232	11,181,846	9,400,000[3]
United Kingdom	233,467,478	233,216,071	166,992,000
United States	502,534,410	586,000,000	448,600,000
Other countries	46,553,865	49,068,527	[1]
Totals	1,170,400,000	1,305,000,000	1,100,000,000

[1] Estimate included in total. [2] Includes Saar and Upper Silesia. [3] Estimated from 11 months' production.

Whiteside, of the Section of Foreign Mineral Reserves, presents the information received by the Geological Survey up to February 15, 1922. The tonnage of the countries not yet heard from ordinarily amounts to 12 or 15 per cent. of the total. Receipt of data for these missing countries, estimates for which are included in the total, may raise or lower the final figure by some millions of tons. The unit used is the metric ton of 2,205 pounds, the approximate equivalent of the long or gross ton. It is not, however, exactly the same, and the translation from net or gross tons to metric tons gives many of the figures an unfamiliar look. A more complete report on world production in 1921 will be issued by the Geological Survey about April 1.

THE MOUNT EVEREST EXPEDITION

WE learn from the London *Times* that the preparations for this year's Mount Everest expedition are now complete. The nine members who have left England for India are:

Brigadier-General the Honorable C. G. Bruce, C.B., chief of the expedition.

Lieutenant-Colonel E. L. Strutt, C.B.E., D.S.O., second in command.

Mr. G. L. Mallory, who led the climbing party in 1921.

Mr. George Finch, of the Imperial College of Science.

Major E. F. Norton, D.S.O., R.F.A.

Mr. T. Howard Somervell, F.R.C.S., of University College Hospital.

Dr. A. M. Wakefield, of Megantic, Quebec Province.

Dr. T. G. Longstaff, surgeon and naturalist.

Captain J. B. L. Noel, M.G.C., photographic officer.

The party will be joined in India, the *Geographical Journal* published by the Royal Geographical Society states, by Captain Geoffrey Bruce, Fifth Gurkhas, and by Captain C. J. Morris, Third Q.A.O. Gurkhas. The twelfth place was to have been filled by an artist, but to the great disappointment of the committee it was not possible to find one among those whose methods seemed appropriate, who could undertake the journey. Of the eleven members of the expedition named above six are soldiers—three of the Gurkhas, one of the Royal Scots, one Royal Field Artillery, and one Machine Gun Corps, formerly of the East Yorkshire Regiment.

Three members of the party are of Cambridge University—Mr. Mallory, of Magdalene, Mr. Somervell, of Caius, and Dr. Wakefield, of Trinity; two are of Oxford University—Colonel Strutt and Dr. Longstaff, both of Christ Church; three are surgeons; two are naturalists, several are expert photographers, one at least is a painter, and all are distinguished mountaineers. It is, in fact, a very strong party, of which much is expected.

The climbing equipment includes an oxygen apparatus specially devised for the occasion. The photographic outfit is very complete, including three cinematograph cameras, of which one is equipped with a battery of lenses up to 20-inch focal length; two panoramic cameras, of which one rotates through the complete circle; four cameras for glass plate, including one 7½-inch by 5-inch, all fitted with telephoto lenses; one stereoscopic camera, and five Kodaks, besides a variety of private cameras belonging to different members of the party. The dark-room equipment includes all that is required for developing cinematograph films in the field.

General Bruce, with his two assistants, Captain Geoffrey Bruce and Captain Morris, are at Darjeeling making preparations for the start of the expedition at the end of the month. They will be especially concerned with the two most important matters, first, the organization of the special corps of Himalayan coolies enlisted from Nepal and the borders of Sikkin and Tibet, and, secondly, with transport arrangements, which require careful and methodical planning, for the expedition is larger this year than last, and is more fully equipped.

Telegrams will be dispatched from the expedition describing its progress, and will be published in *The Times*. A book containing a full account of last year's reconnaissance, with a new map and illustrations, is now going through the press, and will be published by Edward Arnold by the end of next month or the beginning of May. The *Geographical Journal* will contain monthly notices of the progress and results of this year's attempt to reach the summit.

THE AMERICAN CHEMICAL SOCIETY

THE American Chemical Society, which will meet in Birmingham, Ala., from April 3 to 7, expects an attendance of from 700 to 1,000 chemists. It was planned to leave Washington, D. C., on March 30. March 31 will be spent at Kingsport, Tenn., where the Clinchfield Portland Cement Plant and several large extract plants and tanneries are located, together with numerous other chemical industries. April 1 will be spent at Chattanooga, Tenn., and April 2 will be spent at Muscle Shoals, Ala., the site of the large government cyanamid plant and the Wilson power dam. The special train will arrive in Birmingham on April 3.

The following divisions of the society will meet and discuss technical and scientific problems and developments: Agricultural and Food Chemistry, Biological Chemistry, Dye Chemistry, Industrial Engineering Chemistry, Organic Chemistry, Chemistry of Medicinal Products, Physical and Inorganic Chemistry, Rubber Chemistry, Water, Sewage and Sanitation Chemistry, Sugar Chemistry, Cellulose Chemistry, Petroleum Chemistry, Chemical Education and History of Chemistry.

Dr. Edgar F. Smith, president of the American Chemical Society, will turn over to the society dies for the Priestley Medal together with funds which have been donated for the purpose of presenting every two years a medal for the most distinguished service to the science and industry of chemistry, and will make the address of welcome.

Dr. Van H. Manning, former chief of the Bureau of Mines, will present a paper on "The pioneer's field in petroleum research." Dr. Charles L. Reese will give a paper on "Informational needs in science and technology," and Dr. W. C. Geer will speak on "Recent developments of the chemistry of rubber."

Meetings of the various divisions will occupy Wednesday April 5, and Thursday, April 6, concluded with a banquet at the Hotel Tutwiler on Thursday night. Friday, April 7, will be spent in excursions to the steel, by-product, coke and other industries in and around Birmingham. George Gordon Crawford is the honorary chairman and J. F. Carle, of the Southern Testing Laboratories, is chairman of the executive committee in Birmingham in charge of the local arrangements.

Permission to visit the nitrate plant and water power development at Muscle Shoals has been limited by the government officials to American citizens and to those who have no personal connection with or financial interest in the manufacture of cyanamid.

One of the avowed purposes of the meeting is to gather support, by writing congressmen and senators, for the passage of the reclassifi-

cation bill as reported by the Senate civil service committee, which provides for higher salaries for scientific men employed by the government.

THE JOHN SCOTT MEDAL FUND

THE Board of Directors of City Trusts, having charge of the John Scott Medal Fund, has recently awarded the John Scott Medal and Certificate, with premium of $800, to each of the following, for the inventions named:

William Duane, Ph.D., of Boston, Mass., for "his researches in radio-activity and the physics of radium and of X-rays."

Reginald Aubrey Fessenden, of Chestnut Hill, Mass., for "his invention of a reception scheme for continuous wave telegraphy and telephony."

Elwood Haynes, of Kokomo, Indiana, for "his discoveries in connection with stainless steel, stellite, chrome-iron, etc."

Thomas B. Osborne, Ph.D., of New Haven, Conn., for "his researches on the constitution of the vegetable proteins."

JOHN SCOTT MEDAL FUND

Extract from power of attorney to carry out certain provisions in the will of John Scott. Dated April 2, 1816:

. . . that the interest and dividends to become receivable . . . be laid out in premiums to be distibuted among ingenious men and women who make useful inventions; but no one of such premiums to exceed twenty dollars, and along with which shall be given a copper medal with this inscription "To the most deserving," conformably to the tenor of the will of the said testator, John Scott, deceased.

Decree of the Court of Common Pleas of Philadelphia:

And now, this nineteenth day of February, A. D. 1919, the report of the master having been duly filed and no exceptions having been taken thereto, it is adjudged and decreed that the same be confirmed, and that the Board of Directors of City Trusts having in charge the trust created under the will of John Scott, deceased, be authorized and directed in the administration of said fund to distribute the income arising from the fund as it stands with its accumulations as of the date of this decree, in premiums to be distributed among ingenious men and women who make useful inventions, but no one of such premiums to exceed eight hundred dollars ($800.00) in value (increased under decree of court, dated November 29, 1921, to $2,000.00); and along with such premium shall be given a copper medal with this inscription, "To the most deserving" conformably to the tenor of the will of the said testator.

It is further ordered and decreed that in the selection of the recipients, the said trustees shall be at liberty to make such rules and regulations for enabling them to make a wise selection of beneficiaries either by the selection of an advisory board or otherwise, as they may deem best. The premiums shall be awarded for useful inventions which shall include any inventions that will be useful to mankind in the advancement of chemical, medical or any other science or in the development of industry in any form; the test being that the invention is, in the judgment of the trustees, definitely accomplished, and that it may add to the comfort, welfare and happiness of mankind.

Resolution adopted by the Board of Directors of City Trusts:

Resolved, That the award of medals under the John Scott Medal Fund be made hereafter upon the recommendation of an advisory board, to consist of five persons, to be appointed by the Board of Directors of City Trusts; three to be nominated by the National Academy of Sciences, one by the University of Pennsylvania, and one by the American Philosophical Society; all of said nominees to be acceptable to the Board of Directors of City Trusts; the recommendations of the Advisory Board to be made on a majority vote.

Personnel of the Advisory Committee:

National Academy of Sciences: H. H. Donaldson, Theobald Smith, W. B. Scott.

University of Pennsylvania: Arthur W. Goodspeed.

American Philosophical Society: Samuel M. Vauclain.

SCIENTIFIC NOTES AND NEWS

DR. HANS ZINSSER, professor of bacteriology in the College of Physicians and Surgeons, Columbia University, formerly in charge of the sanitary inspection, successively in the first and second army corps, American Expeditionary Forces, was awarded the distinguished service medal at Governors Island, on March 17, for his successful operation of a plan of

military sanitation and epidemic disease control.

THE Fenger Memorial Fund has allotted a grant of $400 for the extension of work now being carried out by Dr. M. G. Seelig on some uses of magnesium in surgery. This work is being conducted in the surgical laboratories of the Washington University School of Medicine.

THE British Medical Association has awarded its gold medal to Sir T. Clifford Allbutt, regius professor of physic in the University of Cambridge, for his distinguished services to the profession and the association, and in commemoration of his five years' presidency of the association in the time of the war.

THE Founder's Medal of the Royal Geographic Society has been awarded to Colonel Howard Bury, the leader of last year's Everest expedition, as a token of appreciation for what the society considers the most noticeable geographic achievement in the last twelve months. The presentation was made by Sir Francis Younghusband, president of the society.

THE Society of Sigma Xi of the University of Iowa has elected to membership Dr. L. Wallace Dean, dean of the college of medicine; Dr. Samuel T. Orton, head of the psychopathic hospital; Lorle I. Stecher of the Iowa Child Welfare Research Station; Clarence W. Hewlett and Edward O. Hulburt, assistant professors of physics. Walter S. Hendrixson, professor of chemistry at Grinnell College, and William Harmon Norton, professor of geology at Cornell College, are initiates from other institutions.

DR. VICTOR F. HESS, technical director of the United States Radium Corporation, has been appointed consulting physicist of the United States Bureau of Mines.

WILLIAM H. RHODES, JR., who has been senior highway engineer, U. S. Bureau of Public Roads, has accepted the position of maintenance engineer with the Louisiana Highway Commission.

DR. W. J. HUMPHREYS writes that on page 312 of SCIENCE for March 24, it is stated through an error that got into the rough minutes that N. L. Bowen will be the new secretary of the Geodetic Section of the American Geophysical Union. Wm. Bowie, the present secretary of the section, will continue to hold that office.

DR. F. F. RUSSELL and Dr. Richard M. Pearce have arrived in South America to promote the work of the Rockefeller Foundation.

JOHN R. FREEMAN, JR., returned recently to the Bureau of Standards from a seven months' trip to Europe, where he visited, for the Bureau of Standards, the principal metallurgical laboratories of France, Germany and England. While in England he worked for about two months in the metallurgical department of the National Physical Laboratories under Dr. Walter Rosenhain.

DR. RAYMOND PEARL, professor of biometry and vital statistics at the Johns Hopkins School of Hygiene and Public Health, will deliver the ninth Harvey Society lecture at the New York Academy of Medicine, on Saturday evening, April 8. His subject will be "The interrelations of the biometric and experimental methods of acquiring knowledge, with special reference to the problems of the duration of life." The lecture on March 25 was given by Dr. W. J. V. Osterhout, professor of botany in Harvard University, on "The mechanism of injury, recovery and death."

PROFESSOR EDWARD S. MORSE, curator of the Peabody Academy of Science, gave a lecture at the Buckingham School, Cambridge, on March 25, on "Some experiences of a collector."

PROFESSOR EDWARD KASNER, of Columbia University, spoke on "Dimensionality in Einstein's cosmological theories," at Princeton University on March 14.

DR. F. W. ASTON, F.R.S., of Cambridge University, addressed the Physical Colloquium of the Western Electric Company in New York on March 13 on the subject, "Isotopes."

DR. THOMAS LEWIS, of London, will deliver the seventh Mellon lecture before the Society of Experimental Biology of the School of Medicine of the University of Pittsburgh, on "Clinical electrocardiography," on May 8.

THE Guthrie lecture of the Physical Society was given on March 24 at the Imperial College of Science, by Professor N. Bohr, who took as his subject, "The effect of electric and magnetic fields on spectral lines."

SIR ERNEST RUTHERFORD will deliver a lecture on the "Evolution of the Elements" before the Royal Institution on April 7. Recent lectures before the institution include one by Thomas R. Merton on the "Problems in the variability of spectra," and one by A. P. Laurie on "The pigments and mediums of the old Masters."

The John M. Dodson lecture of the Rush Medical College, established by the alumni in 1919 in recognition of Dr. Dodson's service to the college, was delivered on March 17 by Dr. Ray Lyman Wilbur, president of Stanford University, whose subject was: "Medicine: a look ahead."

As a memorial to Alfred Noble in recognition of his distinguished achievements in the field of engineering, a bronze tablet, the gift of the American Institute of Consulting Engineers, was unveiled on March 15 in the Engineering Societies Building, New York. Charles W. Leavitt, consulting engineer, made the address of presentation and J. Davies, consulting engineer, accepted the memorial in behalf of the United Engineering Society.

IT is proposed to appoint a committee for the purpose of collecting the necessary funds with which to erect a monument to Professor Chauveau, who died in January, 1917. M. Chauveau was formerly president of the Paris Academy of Sciences, the Academy of Medicine, the Society of Biology and the French Association for the Advancement of Science.

THE balance of the Rayleigh Memorial Fund has been given to the library of the Cavendish Laboratory. The library is to be called the Rayleigh Library. Six hundred pounds is to be separately invested in the Rayleigh Library endowment fund for experimental physics, and the income accruing is to be paid to the Cavendish professor for the purposes of the library.

THE *Journal* of the American Medical Association states that the tenth anniversary of the death of Lister brings within view the completion of a scheme to honor his memory. Soon after his death the question of a memorial was taken up, but the war prevented its being carried out. A representative committee was appointed, and collected $60,000, which was subscribed from all over the world. Out of this has been established the International Lister Fund for the Advancement of Surgery. A sum of $2,500, with a bronze medal, will be awarded every three years, irrespective of nationality, in recognition of distinguished contributions to surgery, the recipient being required to give an address in London under the auspices of the Royal College of Surgeons. Sir Thomas Brock, the sculptor, has executed a memorial tablet to Lister, which was unveiled in Westminster Abbey in 1915. He is at present engaged in designing a bronze bust to be mounted on a pedestal in Portland Place, near Lister's last home. The bust and pedestal will stand about 21 feet high.

THE death is reported at Charleston, S. C., of Captain William C. Hodgkins of the Boston field station of the United States Coast and Geodetic Survey, at the age of sixty-eight years.

PHILIP ARGALL, mining engineer, an authority on metallurgy, died in Denver, on March 19, at the age of sixty-eight years.

THE annual meeting of the American Oil Chemists' Society will be held at the Grunewald Hotel, New Orleans, on May 8 and 9. A large attendance is anticipated and arrangements are being made for entertainment, as well as the usual program of business.

ESTABLISHMENT of fellowships in medicine to increase the supply of qualified teachers and investigators, is announced by the National Research Council. The fellowships, supported by appropriations of the Rockefeller Foundation and the General Education Board, will be open to Americans or Canadians of either sex holding or qualified to hold degrees of doctor of medicine or doctor of philosophy from approved universities. The appropriations are $100,000 a year for five years. Successful candidates, to be known as Fellows in Medicine of the National Research Council, will be at

liberty to choose the institutions or universities in which they will work. The fellowships in medicine are similar to the fellowships in physics and chemistry established under the same auspices.

THE triennial competition for the prize known as the George Montefiore Foundation, which was won last year by Dr. J. B. Whitehead of the Johns Hopkins University, is again announced by the Association des Ingénieurs Electriciens sortis de l'Institut Electrotechnique Montefiore, of which L. Calmeau, rue Saint-Gilles, 51, Liège, Belgium, is general secretary. This prize, amounting to 21,000 francs, is awarded for the best original work in French or English, upon the scientific advance of electricity and its technical applications. Though known as the competition of 1920, the next award will be made in 1923, and works may be submitted up to April 30 of next year.

THE annual conversazione of the British Institution of Electrical Engineers will be held at the Natural History Museum, London, on June 29.

THE British Iron and Steel Institute will hold its annual meeting on May 4 and 5 at the house of the Institution of Civil Engineers, Great George Street, S. W. 1, London.

THE twentieth International Congress of Americanists is to meet definitely at Rio de Janeiro on August 20-30, 1922, under the Presidency of Dr. Lauro Muller.

THE second meeting of the informal group known as the "Boston Psychologists" was held at Wellesley College on Saturday, March 18. At the afternoon session questions of laboratory policy and the place of mental tests in systematic psychology were discussed. The dinner was followed by a toast to Professor Sanford, of Clark University, in recognition of his return to an active part in psychology. The subject for special discussion at the evening session was the status of the practicing and consulting psychologist. Twenty-five psychologists from many of the New England colleges and universities attended the meetings. The first gathering of the group took place at Harvard University last November. The invitation to hold the next meeting at Clark University next fall was accepted.

THE Council of the Optical Society of America has decided to hold an optical instrument exhibit during the annual meeting of the society at the Bureau of Standards, Washington, D. C., the latter part of October next. The director of the bureau has offered the necessary space for this exhibit. To enable the exhibit committee to plan the space adequately and assign it equitably, it requests those interested to submit the following information: (1) What instruments are offered for exhibition? (2) How much floor space would be necessary? (3) What additional facilities other than space will be needed? When this information is at hand the exhibit committee will notify the prospective exhibitors of the amount of space allotted to them. It will also see that the general laboratory facilities necessary are provided. The exhibitors will install their own exhibits and meet the expenses incident thereto.

A SMALL party of scientific men from the University of Iowa will visit islands in the Polynesian group next summer in order to obtain material for the university's laboratories and museums of natural history. Included in the group will be Professor C. C. Nutting, head of the department of zoology; Professor R. B. Wylie, head of the department of botany; Professor A. O. Thomas, geologist; Professor Dayton Stoner, entomologist and ornithologist, and Waldo S. Glock, meteorologist and photographer. In the interest of economy as well as for the sake of securing better specimens for student use, the University of Iowa for many years has maintained the policy of granting leave of absence to its men in search of such material instead of buying from dealers.

UNIVERSITY AND EDUCATIONAL NOTES

A CONTRACT has been let for a new medical building at the University of Alabama, Tuscaloosa, at a cost of $82,000. Construction work will be started immediately.

THE University of Strasbourg has recently made a report in which it is stated that in the

university year 1920 there were 1,505 students; in the year 1921 there were 2,415, and at present there are over 2,600, and there is every prospect that the increase will continue. Provision for further development has been made there by 175 professorships in the place of 90 chairs before the war.

CLAUDE BURTON HUTCHISON, professor of plant breeding of Cornell University, has been selected by the regents of the University of California to head the activities of the branch of the College of Agriculture at Davis and to become professor of plant breeding.

DR. D. H. DOLLEY, professor of pathology at the University of Missouri, has been appointed director and professor of pathology in the St. Louis University School of Medicine. Dr. R. L. Thompson has resigned as director but will continue in the department.

DR. H. R. DEAN, professor of pathology and pathological anatomy in the University of Manchester, has been appointed to the university chair of bacteriology at the University of London, tenable at University College Hospital Medical School.

DISCUSSION AND CORRESPONDENCE

SELECTIVE FERTILIZATION AS AN INDICATOR OF GERMINAL DIFFERENCES

IT has been argued from time to time that the qualities which separate species are essentially different in kind from the visible variations which the geneticists are now busily describing in terms of genes. The position of those who take the affirmative side is fairly stated, I believe, in the following quotation from Bateson's recent address before the American Association for the Advancement of Science:

> Analysis [of the hereditary traits of animals and plants] has revealed hosts of transferable characters. Their combinations suffice to supply in abundance series of types which might pass for new species, and certainly would be so classed if they were met with in nature. Yet critically tested we find that they are not distinct species and we have no reason to suppose that any accumulations of characters of the same order would culminate in the production of distinct species. Specific differences therefore must be regarded as probably attaching to the base upon which these transferables are implanted of which we know absolutely nothing at all. Nothing that we have witnessed in the contemporary world can colorably be interpreted as providing the sort of evidence required.[1]

At this time lack of knowledge concerning the primary factors of evolution makes the stand of the agnostic undoubtedly a safe one and the one which may be the most conducive to real progress in the end. At the same time there is some evidence which should be considered in connection with the statements made in the quotation.

It has been shown conclusively in one species that fertilization takes place less readily when the gametes come from unlike forms than when homogeneous unions are made. The discrimination becomes more pronounced as the germinal differences of the uniting individuals are greater.[2] Maize is better material than most plants to show this because of the large number of seeds it produces with one application of pollen, and because the source of the pollen is soon apparent in the characters of the immediately resulting seeds. Mixed pollinations carried out with this organism have shown that the individual's own pollen, when acting in competition with pollen from other individuals of different constitution, is more effective in accomplishing fertilization.

When two different plants of similar type are compared the selective action is small. For example, when two varieties of maize having the same size and form of plant, equal length of growing season, similar seed shape and texture of endosperm and differing only in minor details are tested, the inequality in fertilizing power of the two kinds of pollen is slight although significant. The small difference in genetic make-up of these plants is also shown by the fact that there is very little heterosis exhibited in the increased weight of the crossed seed compared to the self-fertilized seed. But when a small-growing variety having non-starchy endosperm is paired with a larger variety which differs markedly from it in habit of growth, has starchy corneous seeds of very

[1] SCIENCE, 1922, N. S. Vol. 55, pp. 59 and 60.
[2] *Biological Bulletin*, 1920, Vol. 38, pp. 251-289.

different size and shape and possesses important differences in nearly all parts of the plant, the discrimination against the foreign pollen is very pronounced. The result is almost complete non-functioning of the pollen from the dissimilar plants although such pollen when acting alone is capable of normal fertilization. The greater genetic diversity of these two types is also indicated by the fact that the amount of heterosis shown in the increased weight of the crossed seeds is much more than in the previous case of the similar varieties.

There is here exhibited the working of a tendency which acts to set individuals apart. Besides *Zea mays* three other species, representatives of different orders of the two main classes of angiosperms, show the same phenomenon. It is paralleled in the assortative mating of animals from the lowest to the highest. It is not inconceivable that when carried far enough there may be created an impassable physiological barrier separating different groups. As far as can be judged the differences shown by the types used for illustration are the usual qualitative and quantitative characters which we have been thinking of in terms of Mendelian units. Such hereditary characters may not be directly concerned with the selective action but may be merely associated with differences in more fundamental qualities, but whatever these are they are transferable.

Of course this tells us nothing as to how the differences which are correlated with inequality in fertilizing ability arose. But however diverse were the forms which entered into the ancestry of maize they must have been sexually compatible. Individual members of this species which are quite diverse in form and behavior are now showing a marked tendency towards sexual incompatibility. The degree of selectiveness may be no greater now than it was when the species was first founded but the fact that there is a condition of measurable physiological aloofness is reason to suppose that the accumulations of characters of the same order would culminate in different groups being clearly set apart. Given sufficient time specific differences may finally result.

D. F. JONES

CONNECTICUT AGRICULTURAL EXPERIMENT STATION

GRAVITATIONAL ABSORPTION

THE experiments of Majorana[1] on gravitational absorption having attracted considerable notice, it seems well to direct attention to the large amount of experimental evidence to the contrary.

Russell[2] in a recent article has shown that astronomical and tidal phenomena would limit any gravitative absorption to one-thousandth or less of the amount announced by Majorana.

Eichelberger and Morgan,[3] of the U. S. Naval Observatory, have recently published the results of clock observations from 1903 to 1911, reduced so as to show a difference, if any, between the day and night rate. It appears from these results that such a difference can not exceed 0.005 second, about one-tenth that previously announced by the Lick Observatory[4]. The writer is verbally informed that the Naval Observatory results from 1913 to 1918, reduced but not yet published, bring this slight difference to a still smaller figure.

The existence of gravitative absorption should cause a pendulum clock to run slower by night than by day, on account of the absorption by the earth of the gravitative action between the pendulum bob and the sun. Taking Majorana's coefficient of absorption (6.7×10^{-12}) the average absorption of gravitation by the earth during the night would amount to about three per cent. of the solar gravitative acceleration at the distance of the earth, which is about 0.0006g. The total gravitative acceleration to which the pendulum bob is subjected would therefore be reduced at night by about 0.00002g, or 2 parts in 100,000, and the average time of swing increased by 1 part in 100,000.

Taking 0.005 second as the greatest permissible change in 12 hours, the observations of Eichelberger and Morgan would limit the change in time of swing to something like 1 part in nine million.

Majorana himself, in a later series of experi-

[1] *Phil. Mag.*, 39: 488, 1920. *Atti della Reale Accademia dei Lincei*, 28, 1919, and 29 1920.

[2] *Astrophysical Journal*, 54: 334, 1921.

[3] *Astronomical Journal*, No. 795, January 1922.

[4] *Lick Observatory Bulletin*, No. 330, April, 1921.

ments[5] carried out with a much more massive screen (9603 Kg. lead instead of 104 Kg. mercury) apparently finds an absorption coefficient of only one-third the value given by his earlier experiments. The actual difference in weight found was only 0.002 milligram. In view of the extremely small quantity to be detected and the large amount of evidence against the existence of such an effect, it may be fairly assumed that Majorana's result is in error.

PAUL R. HEYL

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SCIENTIFIC BOOKS

A Study of Some Social Beetles in British Guiana and of their Relations to the Ant-plant Tachigalia WM. M. WHEELER. Zoologica, Dec. 24, 1921.

Five Years' Observations (1914-1918) *on the Bionomics of Southern Nigerian Insects, chiefly directed to the Investigation of Lycænid Life-histories and to the Relation of Lycænidæ, Diptera and other Insects to Ants.* CHARLES O. FARQUHARSON. Trans. Entomological Society of London, 1921. (Published January, 1922).

THERE are many excellent reasons for the study of insects. They constitute the majority of living animals, so far as at present known; and in their relations to one another and to the environment present biological complexes the analysis of which tests the powers of the keenest observers. We go to the Protozoa to find the problems of heredity and environment reduced to the simplest terms; but we turn to the world of insects to learn what life can do in developing the most intricate, diverse, and many-sided adaptive mechanisms and habits. It may be said that the most elaborate poem consists of nothing but letters of the alphabet, and in the same sense all the phenomena of insect life are implied in the simpler reactions of unicellular animals. But after all, the poem is very much more than letters or words, and the biologist who tries to express the masterpieces of vital activity in terms of simple and universal reactions can only do so by shutting his eyes to the real nature of the phenomena. It is, in fact, necessary to look in two directions at once; to be equally alert to detect general laws or principles, and to perceive special cases, which in a real and significant sense are unique.

Not only do the insects thus illustrate the wonders of life, but they afford us excellent material for evolutionary studies, whereby we may eventually understand in some measure how the most complex structures and reactions arose. They do this because the species are so excessively numerous, and there is every reason to suppose that much of their evolution has been *lateral;* that is, by the development of segregates without the disappearance of the original stock. Thus it may well happen that a sufficiently extensive collection will show a series of forms, along with their prototypes, the latter still existing under the original conditions. Recent studies have revealed the existence of many slightly divergent races or species, more or less different in their adaptations and reactions, exposing the very mechanism of evolution to our view. These phenomena, read in the light of the remarkable genetic studies on *Drosophila* and other insects, begin to acquire extraordinary significance and interest. It must further be said, that if we are to take full advantage of the wealth of biological opportunity afforded by the insects, we must turn to the tropics, where the number and diversity of species is at a maximum. In the tropics essentially similar climatic conditions have persisted for ages, permitting the development of biocoenoses which may be compared with old and highly diversified civilizations. But the detection and analysis of these requires resident study or permanent stations, as the English naturalist, A. R. Wallace, long ago insisted. Expeditions, traveling rapidly over the country, appear more adventurous or romantic, and often return with very large collections; but any one who has occasion to study the specimens so collected, must keenly realize the lack of biological information.

For all these reasons, the Tropical Research Station in British Guiana, established by Mr.

[5] *Comptes Rendus,* 173: 478, 1921.

William Beebe, is certain to become classical ground. Not only is the station most favorably situated for research, but it is securing the interest and cooperation of some of the most brilliant American naturalists. Although much work has already been done, it represents no more than a minute inroad on the resources of the locality. But whatever may be accomplished hereafter, it will not often happen that any more interesting story will be written than that by Dr. W. M. Wheeler on the insects associated with the plant *Tachigalia*. This genus of leguminous trees has long been known to harbor ants within the enlarged and hollowed petioles. The very name of the genus was derived by Aublet (1775) from the native name indicating this association. Dr. Wheeler, in the short time at his disposal, was able to detect no less than 50 species of organisms associated primarily with the leaves or terminal shoots of the plant, or secondarily with the organisms thus associated. Twenty-eight of these were ants, half of them representing new species, subspecies or varieties. The others included various kinds of insects, seven of which proved to be undescribed, and have been discussed in short supplementary articles by a number of specialists. The regular or normal inhabitants of the petioles are certain ants, beetles and coccids. The ants comprise two species of *Pseudomyrma* and two of *Azteca*. The coccids are all of one species, identified as *Pseudococcus bromeliæ* (Bouché)[1]. The beetles have been described by Messrs. Schwarz and Barter, of the U. S. National Museum, and are found to represent two species of Silvanidæ, one of them so remarkable as to be placed in a new genus. The discussion centers around these beetles, which prove to have very singular habits. Both adults and larvæ feed on the parenchyma of the *Tachigalia* petioles, but they also solicit and drink the sugary excrement of the coccids. When a beetle finds a coccid, it proceeds to apply its antennæ to the rounded surface of the mealy-bug's back, like "an expert pianist moving his hands from side to side over the key-board, or a masseur with his hands in soft gloves, massaging a patient." The beetle may spend as much as forty or more minutes in this operation. If the coccid is in the proper condition, it discharges a drop of liquid, which the beetle at once greedily swallows. The beetles do not seem to be able to judge whether the coccid is capable of responding, and will work for long periods without getting any results. Not only do the adult beetles behave in this manner, but the larvæ also solicit food from the coccids. Dr. Wheeler not only describes the interrelationships of the various insects in considerable detail, but gives a most interesting discussion of the general problems of instinct and habit involved; a discussion which has the advantage of being based on a minute knowledge of actual facts, rather than general presumptions as to what ought to be true. This discussion ends with a speculative passage which can not fail to attract the reader's attention.

"Fouillée believes that every appetition involves a rudimentary cognition and that automatic behavior like that of the habits and reflexes is merely lapsed appetition. If it could be shown that the latter really can have this derivation and that such ontogenetic mechanisms as habits can acquire representation in the germ-plasm and hereditary transmission, we might be in a position to give a consistent account of all animal behavior, and one which would lead us to regard the reflexes and the tropisms as ultimate, highly specialized end-stages instead of primitive, elemental components of behavior" (p. 118).

Charles O. Farquharson was trained in the University of Aberdeen, and went out to Nigeria as government mycologist. Through Dr. W. A. Lamborn, entomologist at the same station, he became interested in insects, and both men were greatly stimulated by Professor E. B. Poulton of Oxford, with whom they constantly corresponded. Owing to conditions arising out of the war, Farquharson was obliged to spend

[1] Bouché's description, quoted by Signoret, is partly inaccurate, and may not refer to a *Pseudococcus* at all. The current identification of the species is traditional, and probably cannot be justified or confirmed. The "*P. bromeliæ*" found on pineapples in Florida (Quarterly Bull. State Plant Board of Florida, October, 1917, p. 47) is almost certainly *P. brevipes* (Ckll.), and cannot be Bouché's species.

much of his time in doing routine work unconnected with sciences, but he managed to make a great number of interesting observations, which he hastened to communicate to Professor Poulton in letters, along with specimens of most of the species referred to. He hoped, on returning home, to work up his results and publish his more important discoveries, but he lost his life through a collision at sea within a few hours of Liverpool. Professor Poulton has edited his letters, adding a brief memoir and numerous notes, together with a series of contributions, from specialists, describing many of the new or interesting species found.

The paper is so long, and its contents are so varied, that it is impossible to give an adequate summary. The principal section, however, refers to the transformations and habits of a number of species of Lycaenidae, and brings out a number of new and curious facts. It is a strange coincidence, that almost simultaneously with Dr. Wheeler's publication of the observation of beetles obtaining liquid nourishment from coccidæ in South America, Farquharson's account of similar habits in Lycænid butterflies in Africa appears. The butterfly concerned is *Teratoneura isabellæ,* a long account being given, showing that the attending ants are driven away, apparently by flapping the wings. Professor Poulton suggests that an offensive odor is also produced. Later, two other related butterflies, of distinct genera, were found to have the same habits. Unfortunately the coccids were not preserved, and we can only conjecture that they were some species of *Pseudococcus.* Both of the works reviewed were capable of being completed only by the cooperation of rather numerous specialists, entomologists and botanists. It becomes increasingly evident that much of the best work in bionomics must necessarily be cooperative, no single individual, however learned, being capable of dealing with all of the species and problems involved. It is pleasant to find, in the papers before us, that the desired assistance was freely given and is completely acknowledged. Only in this spirit is it possible for men to work harmoniously together, and any who fail to conform to proper standards should be made to feel the disapproval of their colleagues.

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SPECIAL ARTICLES

SEALING TUNGSTEN INTO PYREX

THE author has spent considerable time in evolving a good method of sealing tungsten wire into Pyrex and fastening the copper lead-wires to the tungsten. The method here described is easily accomplished and the freedom from breakage is certain. It is hoped that the present detailed description may save others sufficient time to justify its publication. An elementary knowledge of glass-blowing is assumed.

The sealing-in glasses and the order of joining are:

tungsten—G705H—G702P—Pyrex.

The numbers are used by the Corning Glass Company to designate these glasses. Some glass-blowers prefer to omit G705H and seal the tungsten directly to G702P. The G705H is of lower melting point, may be used in the gas-air flame and hence offers less chance to oxidize the tungsten.

Clean the wire by sandpaper only or warm in the flame, dip in a saturated aqueous solution of sodium or potassium nitrite (or nitrate) and then polish with very fine sandpaper or even the thumb nail. Draw small tubes of each of the three kinds of glass having an internal diameter slightly larger than the diameter of the wire. Cut a short length from each and string them on the wire in the order (above) in which they are to be sealed. The flame should be applied first to the middle of the G705H bead and the others in turn be brought along the wire and melted to the preceding one. The wire with its glass coating, Fig. 1-a, may then be sealed in in the usual manner but joining Pyrex to Pyrex. In case the tungsten wire is small and it is desired to protect it from the flame the Pyrex enclosing tube may be extended through the final seal, Fig. 1-b, and the excess glass broken off after the seal is accomplished.

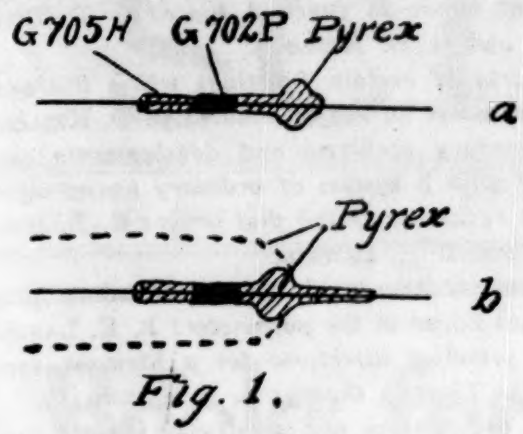

Fig. 1.

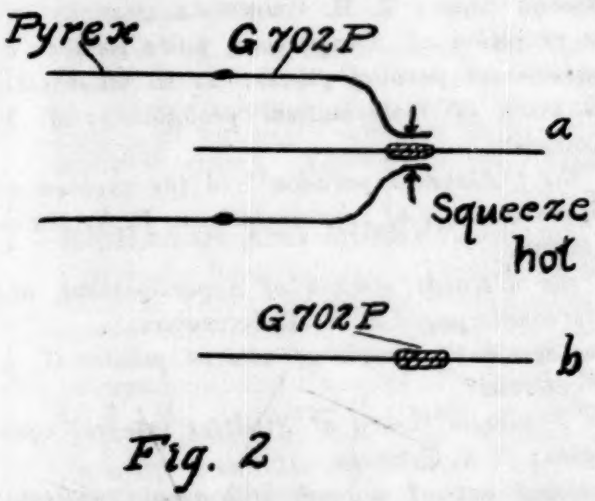

Fig. 2

A seal using only G702P and Pyrex may be made as indicated in Fig. 2. Join tube of G702P to Pyrex and draw down as indicated. The wire coated with a small bead of G702P (or even the bare clean wire) may be placed in position, Fig. 2-a, and the seal made by squeezing with tweezers when hot. Squeeze as soon as possible to prevent oxidation. This seal may also be made by squeezing a bead of G702P in a Pyrex tube but with less freedom from breakage.

To join copper to tungsten:

(a) electroplate tip of tungsten wire with copper or nickel and solder (silver solder for higher temperatures).

(b) melt nickel wire to tungsten in oxygen flame using borax as flux or even no flux. Nickel becomes very brittle and it is best to then solder to the nickel bead thus obtained.

(c) form arc of 10 to 20 amps. between tungsten and nickel wires to coat tungsten with nickel; solder.

(d) German silver (for this use of it I am indebted to Mr. Cummings of the Department of Chemistry of this University) flows much better than nickel. Use method (b) with borax as flux. Copper wire may be joined at once in flame just as in joining copper to platinum.

The method used will generally depend upon facilities available.

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A NEW SCLEROTINIA ON MULBERRY

A DISEASE of mulberry characterized by enlarged portions of the fruit has been noted by Orton[1] and more recently by Taubenhaus.[2] The authors have found a species of Sclerotinia to be the cause of this disease and will describe it as follows in the *Journal of Agricultural Research:*

Sclerotinia carunculoides n. sp.

Apothecia one to several from a single sclerotium, disc cupulate to sub-cupulate; 4 to 12 mm. in diameter; inside snuff-brown,[3] outside Prout's brown; stalk cylindrical, flexuous, smooth, attenuated downward, 15 to 42 mm. in length, reaching a diameter of 1.5 mm., color Prout's brown; asci cylindrical to cylindro-clavate, 104 to 123 x 6.4 to 8 μ, average 117 x 7 μ, 8-spored; ascospores uni-seriate, reniform, hyaline, 6.4 to 9.6 x 2.4 to 4 μ, average 7.6 x 3.1 μ, with 2 bodies on the concave surface; namely, a body more or less rhombic in shape as seen from above, 2 x 4 μ, and adjoining it, a more or less hemispherical body 3 μ in its longest diameter; paraphyses filiform to cylindro-clavate, simple or branched, septate or non-septate, 94 to 128 x 1.8 to 2 μ; microconidia hyaline, sub-globose, 2 to 4 x 2 to 3.2 μ, average 2.8 x 2.5 μ; sclerotia black, fairly regular, sub-spherical with depressed surfaces.

[1] *Experiment Station Record,* Vol. XIV, No. 6, pp. 351-352, 1903.

[2] *Nature Study Review,* Vol. 17, No. 7, pp. 282-285, 1921. Illus.

[3] Ridgway, Robert, *Color standards and color nomenclature,* 43 p., 53 col. pl., Washington, D. C., 1912.

On fruits of cultivated *Morus alba*. Type material collected at Scranton, S. C., U. S. A., March, 1921. Specimens have been deposited in the Office of Pathological Collections, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

The manuscript giving a more complete account of this organism went to press November 26, 1921, but since congressional action has suspended the publication of the *Journal*, it is deemed advisable to publish this preliminary account at this time in order that plant pathologists interested in this disease may be on the watch for the apothecial stage at blossoming time.

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FEBRUARY 1, 1922

THE AMERICAN MATHEMATICAL SOCIETY

THE two hundred and twenty-first regular meeting of the American Mathematical Society was held at Columbia University, New York City, on February 25, 1922. The attendance included seventy-five members of the society. The election of thirty-five new members was announced.

The secretary announced the gift, by an anonymous donor, of the sum of $4,000 to pay for an additional volume of the *Transactions*, to be printed in 1922. The society adopted a resolution thanking the donor for this very generous gift.

Professor C. N. Haskins, of Dartmouth College, was selected to succeed Professor L. E. Dickson, of the University of Chicago, as one of the three representatives of the society in the Division of Physical Sciences of the National Research Council.

The afternoon session was especially marked by the presentation of a paper by Professor J. L. Coolidge, by request of the program committee, on *The basis of mathematical probability*. A number of members of the Actuarial Society attended, by invitation, to hear this paper.

The following papers were read:

Invariant points in function space: G. D. BIRKHOFF and O. D. KELLOGG.

A property of certain functions whose Sturmian developments do not terminate: O. D. KELLOGG.

The boundary problems and developments associated with a system of ordinary linear differential equations of the first order: G. D. BIRKHOFF and R. E. LANGER.

Developments associated with a boundary problem not linear in the parameter: R. E. LANGER.

Ricci's principal directions for a Riemann space and the Einstein theory: L. P. EISENHART.

Normal congruences and quadruply infinite families of curves: J. DOUGLAS.

Qualitative properties of the ballistic trajectory. Second paper: T. H. GRONWALL.

The reflection of X-rays in a finite number of equidistant parallel planes: T. H. GRONWALL.

The basis of mathematical probability: J. L. COOLIDGE.

On the "Alabama paradox" in the problem of apportionment of representatives: E. V. HUNTINGTON.

On the d'Hondt method of apportionment, and its counterpart: E. V. HUNTINGTON.

Theorems on sequences of sets of points: G. A. PFEIFFER.

The Fredholm theory of Stieltjes integral equations: C. A. FISCHER.

A closed set of normal orthogonal functions: J. L. WALSH.

Kinematics in a complex plane and some geometric applications: A. EMCH.

On functions with integrals of elementary character: J. F. RITT.

Geometrical properties of the system of all the curves of constant pressure in a field of force: E. M. MORENUS.

Spherical representation of conjugate systems and asymptotic lines: W. C. GRAUSTEIN.

The distribution of current in a long cylindrical conductor: C. MANNEBACK.

Operational solution of equations of nth degree: A. PRESS.

Maximal cuspidal curves: T. E. HOLLCROFT.

Method for the separation into partial fractions of powers of trigonometric functions: I. J. SCHWATT.

The expansion of the continued product, $\prod_{k=1}^{n}(x+k)$: I. J. SCHWATT.

R. G. D. RICHARDSON,
Secretary